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Transition to full-time employment status based on two-equation and three-equation probit model with endogenous switching

Natalia Nehrebecka*

Faculty of Economic Sciences, University of Warsaw
Department of Statistics, National Bank of Poland
e-mail: nnehrebecka@wne.uw.edu.pl

Abstract

This paper examines employment transitions among men and women in Poland aged between 20 and 65 based on the data from the CHER (Consortium of Household Panels for European Socio-Economic Research). The research results show that the state of the person in a given year is not only dependent upon his/her state in the previous year, but also upon whether he/she was in that state the years before. Moreover, the study proves that the impact of individual characteristics of persons on the conditional probability of retaining a given status depends on the persons' employment record, which confirms the rejection of the null hypothesis regarding the „interdependence of states". As a result of this study, we can determine that, as expected, being in a given state, just like entry in to that state, are conditioned by demographic characteristics and the human capital of the respondent, as well as by the characteristics of the household, although the impact of these variables depends on the occupational background of that person. This implies that every individual may get trapped in non-employment and, ideally, policy should intervene as soon as the individual begins non-employment period. This article also includes statistics describing the duration of each status and time spent outside of the status by persons with different combinations of characteristics calculated based on the parameter estimation of the model.

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Keywords:
two-equation and three-equation probit model with endogenous switching, initial conditions problem, labour market, transitions

JEL:
J48, J21, J64, C25

Introduction

As a result of demographic trends concerning fertility, matrixes of creation of families and aging of population, as well as those concerned with changes in cultural trends, we are witnessing a so far unprecedented increase in the differentiation of preferences in terms of professional activities. For example, in all European countries, to a various degree, women in the fertile period have entered the labour market *en masse*. It is a result of growing earning needs, changes in the value system and increasing, especially in the service sector, possibilities for employment (Sztanderska, 2007). However, the division of household labour does not catch up with these changes, since the needs of women on the labour market (part-time employment, child rearing, benefits, the possibility to withdraw from the labour pool for some as well as the possibility for continuous improvement and uninterrupted career path after such break) are much different from the traditional needs of men – bread-winners with full-time employment. Leira, 2002; Kotowska, 2005b; Matusiak, 2005). Similarly, changes in the value system, life expectancy and health of population provide new forms and requirements regarding possibilities for the older employed to withdraw from the labour market regardless of the pressure these employees exert on the public social insurance system, by fighting for the maintenance of traditional retirement schemes and the accompanying privileges. Simultaneously, changes in technology, known as the „IT revolution" have led to a fundamental change in the relations between production and gaining new knowledge, as well as economic competitiveness. The resulting new requirements demand creating new institutional and educational training programs, as well as new relations between employment and training, so that competences and abilities of labour force may keep up with the pace of change. Finally, globalization provides new multinational division of labour necessitating an increasing flexibility of the European economies in order to maintain national competitiveness.

As a consequence of these jointly acting trends, the standard model of fixed full-time employment, a role traditionally *reserved for men* (women are primarily carers of children and men are breadwinners), is being replaced by many various forms of employment and statuses on the labour market; in the traditional "education then employment," sequence the latter is gradually interrupted by periods of training throughout the entire employment history („lifetime education"). All these changes create new challenges and exert impact on the traditional repertoire of labour market policies and, more generally, on the country with an extended social insurance system.

According to the neoclassical economic theory, an effective method of obtaining mobility in the labour market is creating strong financial incentives, both positive and negative[1]. This means that the main motive of moving from one position/job/employer/activity to another, as well as from unemployment to professional activity, is the relative profits we can achieve and relative losses we can avoid by such change. In other words, to effect a change of labour market status, very strong financial incentives are necessary, e.g. a large change in earnings, sizable loss of income in case of going unemployed. Obviously, this is a theory which is to justify inequalities or provide support for the „Anglo-Saxon market model"[2].

In contrast to the above model, the so-called European Social Model[3] in its different forms is based on the assumption that it is possible to execute flexibility on the labour market at a much lower level of income inequalities, but much higher level of income protection than that of the Anglo-Saxon job system through compensating mechanisms. These include an active labour market policy, training programs, strategies for assigning days off, etc. that improve and fine-tune the functioning of the labour market. In other words, the European Social Model assumes that a country with an extended social insurance system may play an active role in the new society, based on knowledge and education.[4]

[1] Kwiatkowski (1988, 2006).

[2] Subject of „Anglo-Saxton market model" was discussed in the Ziguras,and Stricker's work (2004).

[3] A definition of the European Social Model was adopted by the European Council during the Barcelona summit in March 2002. According to this definition, „A European Social Model is based on an efficient economy, a high level of social protection and education as well as social dialogue" (Pietras, 2005).

[4] More information about the European Social Model can be found in the work by Sztanderska (2003).

The aim of the study presented in this article is to find indicators which have impact on the probability of the person being employed full-time under the condition of his/her status in the earlier years. In the second step of the study, an additional condition of personal status two years earlier will be taken into account..

The main research hypothesis in this article is as follows: the state of the person in a given year is subject to not only his/her employment status in the previous year but also in the earlier years.

The construction of this article is as follows: part one illustrates the methodology applied in this work: the parametric approach (two-equation and three-equation probit model with endogenous switching). The second part includes a description and statistical analysis of the available data. The third part presents the results obtained based on CHER data over 1997 – 2000 in Poland.

1. Methodology

1.1. Specification of the two-equation probit model with endogenous switching

The econometric analysis presents two main reasons for being in a given state : the heterogeneity of individuals and „interdependence of states". In the first case, some fundamental attributes of individuals affect the status that they hold, e.g. lead to a continuous increase in income. In the second case, being in a given state is dependent on having a particular status in the past.

To find variables that have impact on the probability of being in a given state by the person, under the condition of his/her status the year before and two years earlier, the methodology presented by Cappellari (1999, 2000, 2001, 2002, 2007) and Jenkins (1999, 2003, 2006) has been used.

According to Cappellari (2001) income mobility of individuals is conditioned by the initial state that cannot be treated as exogenous[5]. The process of income generation begins prior to the initiation of the study and so the first values of income are not observed by the researcher. The presence of correlations in the discussed process makes the incomes from the earlier years endogenous in relation to the current incomes. This phenomenon is described as the „initial conditions problem". Disregarding this fact, makes the parameter estimators biased. In order to resolve the „initial conditions problem" Cappellari (2000) used a two-equation probit model with endogenous switching, i.e. used a simultaneous solution for two equations: in the first equation („transfer") he modelled probability of being in a given state in year *t*, in the second equation („selection") he modelled a probability of being in a given state in year *t-1*[6]. The main benefit which comes from the application of this approach is the possibility to test the „interdependence of states" hypothesis[7].

Therefore, the aim of this study is to analyze changes in the states of persons between years *t-1* and *t*. The „selection" equation is a probit model used to explain the possibility of the person being in the researched state at the beginning year *t-1*. Its assumed that, in the period *t-1* individuals can be characterized by hidden disposition toward being in the researched state (denoted by y_{it-1}^*) shown as follows:

$$y_{it-1}^* = X_{it-1}'\delta + u_i \tag{1}$$

where:

y_{it-1}^* - hidden disposition of persons toward being in the researched state in year *t-1*;

X_i - a vector of independent variables describing an *i*-th person;

δ - a vector of unknown parameters;

u_i - random error ~ N(0,1).

Then, the binary variable was defined Y_{it-1}, which shows whether an *i*-th person was in a given state in

[5] Heckman (1981a).
[6] Cappellari, Jenkins (2002).
[7] Cappellari (2000).

period *t-1*, that is Y_{it-1}=1, if $y^*_{it-1} > 0$ $Y_{it-1} = 0$ and in others.
The main assumption of the model is that the process generating a hidden inclination of the person toward being in a given state in year *t* is dependent upon the state of the person in period *t-1*:

$$\begin{aligned} y_{it}* &= Z_{it}'\eta_1 + \xi_{1i} \qquad for \qquad Y_{it-1} = 1 \\ y_{it}* &= Z_{it}'\eta_2 + \xi_{2i} \qquad for \qquad Y_{it-1} = 0 \\ \xi_{1i}, \xi_{2i} &\sim N(0,1) \end{aligned} \tag{2}$$

where:

$y_{it}*$ – hidden disposition of persons toward being in the given state in year *t*;

Z_i – a vector of independent variables describing an *i*-th person. Its a subvector X_i, so that all variables included in Z_i are also included in X_i;

η_1, η_2 – vectors of unknown parameters. The vector η_1 includes parameters that show the impact of individual characteristics on the possibility of a given state persisting. The vector η_2 shows the impact of the same characteristics on possibility of moving into it.

This model allows us to include the „interdependence of states" namely, that the effect of the household characteristics on the possibility of being in a given state depends on the state from year *t-1*. Moreover, it was assumed that the total distribution of random errors u_i, ξ_{1i} and ξ_{2i} is a three-dimensional normal distribution:

$$\begin{bmatrix} u_i \\ \xi_{1i} \\ \xi_{2i} \end{bmatrix} \sim \mathrm{N}\left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & & \\ \rho_1 & 1 & \\ \rho_2 & \rho_3 & 1 \end{bmatrix} \right) \tag{3}$$

Where:

ρ_1 – correlation between probabilities of being in a given state in year *t-1* and year *t;*

ρ_2 – correlation between probabilities of not being in a given state in year *t-1* and being in it in year *t;*

$\rho_3 = corr(\xi_{1i}, \xi_{2i})$ is not identifiable[8].

The presence of the „initial conditions problem" can be tested in the following way:

$$\mathrm{H}_0: \ \rho_1 = \rho_2 \tag{4}$$

Under the abovementioned assumptions, a logarithm of the validity function will be as follows:

$$\log L = \sum_i \begin{pmatrix} Y_{it-1}Y_{it} \log(\Phi_2(Z_{it}'\eta_1, X_{it-1}'\delta; \rho_1)) + \\ + Y_{it-1}(1-Y_{it}) \log(\Phi_2(-Z_{it}'\eta_1, X_{it-1}'\delta; -\rho_1)) + \\ + (1-Y_{it-1})Y_{it} \log(\Phi_2(Z_{it}'\eta_2, -X_{it-1}'\delta; -\rho_2)) + \\ + (1-Y_{it-1})(1-Y_{it}) \log(\Phi_2(-Z_{it}'\eta_2, -X_{it-1}'\delta; \rho_2)) \end{pmatrix} \tag{5}$$

where:

Φ_2 – the two-dimensional normal distribution.

Estimation of η_1 is performed on a subsample of individuals, who were in the researched state in year *t-1*, however estimation η_2 can be obtained from the rest of the sample.

[8] Cappellari (2000).

1.1.1 The conditional probability of persistence of a given status and entry onto labour market

The assumptions pertaining to the distribution of errors show that:

$$\Pr(Y_{it}=1, Y_{it-1}=1) = \Phi_2(Z_{it}'\eta_1, X_{it-1}'\delta; \rho_1) \tag{6}$$

$$\Pr(Y_{it}=1, Y_{it-1}=0) = \Phi_2(Z_{it}'\eta_2, -X_{it-1}'\delta; -\rho_2) \tag{7}$$

Thus, we can provide a specific definition of probabilities of being in a given state in year *t* subject to the state of the household in year *t-1*:

- a formula for a the conditional probability of persistence of a given state:

$$s_{it} = \Pr(Y_{it}=1 \mid Y_{it-1}=1) = \frac{\Pr(Y_{it}=1, Y_{it-1}=1)}{\Pr(Y_{it-1}=1)} = \frac{\Phi_2(Z_{it}'\eta_1, X_{it-1}'\delta, \rho_1)}{\Phi(X_{it-1}'\delta)} \tag{8}$$

- a formula for a the conditional probability of entry into a given state[9]:

$$e_{it} = \Pr(Y_{it}=1 \mid Y_{it-1}=0) = \frac{\Pr(Y_{it}=1, Y_{it-1}=0)}{\Pr(Y_{it-1}=0)} = \frac{\Phi_2(Z_{it}'\eta_2, -X_{it-1}'\delta, -\rho_2)}{\Phi(-X_{it-1}'\delta)} \tag{9}$$

1.1.2 Implications of states transition model on labour market for delineating persistence of a given state

The major advantage of the presented first level Markow's model is its the possibility to delineate both the distribution of time of being in a given state and the distribution of time spent outside of a given state (Boskin and Nold, 1975). If we assume, there is a fixed environment, we can calculate the following statistics[10]: an average time of being in a given state: $\frac{1}{1-s_{it}}$, a median time of being in a given state: $\frac{\ln(0,5)}{\ln(s_{it})}$, an average time of being outside of a given state: $\frac{1}{e_{it}}$, a median time of being outside of a given state: $\frac{\ln(0,5)}{\ln(1-e_{it})}$, unconditional probability of being in a given state at a specific point in time: $\frac{e_{it}}{e_{it}+1-s_{it}}$.

1.1.3 Testing „interdependence of states"

The structure of the endogenous switching model allows us to test the hypothesis of the „interdependence of states". We differentiate between the aggregate states dependence (ASD) and genuine states dependence (GSD). ASD is a difference of the probability of being in a given state by a person who was in that state in the previous period and the probability of being in a given state by the person who was outside of that state in that period. This measure however does not include the individual heterogeneity.

[9] Cappellari, Jenkins (2002).
[10] Böheim, Ermisch, Jenkins (1999).

$$ASD = (\frac{\sum \Pr(Y_{it} = 1 \mid Y_{it-1} = 1)}{\sum Y_{it-1}}) - (\frac{\sum \Pr(Y_{it} = 1 \mid Y_{it-1} = 0)}{\sum (1 - Y_{it-1})}) \quad (10)$$

The genuine dependence of states takes place when the possibility of being in a given state depends on being in a given state in the previous period, when controlling for the individual heterogeneity (observed or implicit). For instance, being in an undesired state on the labour market can lower motivation, which in turn may be a reason that the individual, regardless of characteristics, has little chance of getting out of this state in the future. The null hypothesis in the test for the existence of the „interdependence of states" can be formulated as follows[11]:

$$H_0: \eta_1 = \eta_2 \quad (11)$$

GSD is an average difference, for all *N* individuals between the expected probability of being in a given state, under the condition of being in that state in the previous period and expected probability of having a given status on the labour market, under the condition of being outside of that state in the previous period:

$$ASD = (1/N)[\sum \Pr(Y_{it} = 1 \mid Y_{it-1} = 1) - \Pr(Y_{it} = 1 \mid Y_{it-1} = 0)] \quad (12)$$

Calculating differences in the probabilities for individual allows us to control the individual heterogeneity.

1.2 Specification of a three-equation probit model with endogenous switching

In this subsection, the model presented in subsection 1.1 will be extended by an equation showing the state in which the individul was two years before. To model the transfer over three years *t-2*, *t-1* and *t*, a probit model composed of four levels will be used:
- delineating personal status in year *t-2* in order to resolve the "initial conditions problem";
- delineating personal status in year *t-1* under the condition of the status the person held in year *t-2*;
- delineating personal status in year *t* under the condition of the status the person held in years *t-1* and *t-2*;
- assigning a correlation between specific effects of three abovementioned processes.

Similarly, as in the above mentioned subpart, it is assumed that in period *t-2* individuals have a hidden inclination to being in a given state on the labour market (denoted by y^*_{it-2}) shown as follows:

$$y^*_{it-2} = \alpha' X_{it-2} + \mu_i \,,\ \mu_i \sim \mathrm{N}(0,1) \quad (13)$$

where:

$i = 1,\ldots,N$ – an index of a person;

X_i – a vector of independent variables describing an *i*-th person and its household;
α – a parameters vector.

If the disposition of *i*-th person toward being in a given state is higher than some unobserved value (which can equal zero) than that person is in a given state on the labour market. A following designation was used Y_{it-2} for binary variable showing whether the *i*-th person was in a given state, therefore Y_{it-2}=1, if $y^*_{it-2} > 0$ and $Y_{it-2} = 0$ in other cases.

Then, the probability was considered that persons in a given state in period *t-2* will remain in that status also in period *t-1*. Let y^*_{it-1} be a hidden disposition of an *i*-th person to remain in a given state between periods *t-2* and *t-1* described as follows:

[11] Cappellari, Jenkins (2002).

$$y^{*}_{it-1} = [(Y_{it-2})\gamma_1' + (1-Y_{it-2})\gamma_2']Z_{it-1} + v_i, \quad v_i \sim N(0,1) \tag{14}$$

where:

Z_i – a vector of independent variables describing an *i*-th person. It is a subvector X_i ,which means that all variables included in Z_i are also included in X_i ;

γ_1, γ_2 – vectors of unknown parameters. The vector γ_1 includes parameters that show the impact of an individual characteristics on the possibility of the persistence of a given state . The vector γ_2 shows the impact of the same characteristics on the possibility of moving into it.

In the third section, the possibility of remaining in a given state in period *t* was specified. Let us denote this hidden disposition to remain in a given state by:

$$y^{*}_{it} = [Y_{it-1}Y_{it-2}\lambda_1' + Y_{it-1}(1-Y_{it-2})\lambda_2' + (1-Y_{it-1})Y_{it-2}\lambda_3' + (1-Y_{it-1})Y_{it-2}\lambda_4']O_{it} + \varepsilon_i \tag{15}$$

where:

ε_i – a random error $\sim N(0,1)$,

O_i – a vector of independent variables describing an *i*-th person. Its a subvector X_i, so all variables included in O_i are also included in X_i ;

λ_1, λ_2, λ_3, λ_4 - vectors of unknown parameters. The vector λ_1 includes parameters that show the impact of an individual characteristics on the possibility of the persistence of a given state. The vector λ_2 shows the impact of the same characteristics on possibility of moving into it. The vector λ_3 shows the impact of the same characteristics on the possibility of moving into that state under the condition of remaining in the same state in *t-1* and outside of it in *t-2*. The vector λ_4 shows the impact of the same characteristics on the possibility of moving into that state under the condition of being outside of this state in period *t-1* and being in it in *t-2*.

The presented model allows us to incorporate the „interdependence of states" i.e. that the impact of the household characteristics on the possibility of being in a given state depends on the state in year *t-1* as well as *t-2*. The null hypothesis is a test for the existence of a genuine interdependence of states" which can be formulated as follows[12]:

$$H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 \tag{16}$$

Moreover, we can assume that the total distribution of random errors μ_i, v_i i ε_i is a three-dimensional normal distribution with the following independent correlations[13]:

$$\begin{aligned} \rho_{12} &= corr(\mu_i, v_i) \\ \rho_{23} &= corr(v_i, \varepsilon_i) \\ \rho_{31} &= corr(\varepsilon_i, \mu_i) \end{aligned} \tag{17}$$

where:

ρ_{12} – a correlation between unobserved variables that have impact on the initial state of an individual as well as the conditional present state in period *t-1*,

ρ_{31} – a correlation between unobserved variables that have impact on the initial state of an individual, as well as the conditional present state in period *t*,

[12] Cappellari, Jenkins (2002).

[13] Cappellari, Jenkins (2002).

ρ_{23} – a correlation between unobserved variables that have impact on the state of the individual in period *t-1*as well as the conditional present state in period *t.*

A hypothesis concerning the exogeneity of the initial conditions in period *t-2* can be tested as follows:

$$H_0: \rho_{12} = \rho_{31} \tag{18}$$

If the null hypothesis is not rejected, there is no „initial conditions problem", the research status in period *t-2* can be treated as exogenous.

The hypothesis concerning the exogeneity of the initial conditions in period *t-1* can be tested as follows:

$$H_0: \rho_{12} = \rho_{23} \tag{19}$$

If the null hypothesis is not rejected, there is no „initial conditions problem", the research status in period *t-1* can be treated as exogenous.

The hypothesis concerning a total exogeneity of the initial conditions can be tested as follows:

$$H_0: \rho_{12} = \rho_{23} = \rho_{31} \tag{20}$$

If the null hypothesis is not rejected, this means that the status in which the person was in year *t-2, t-1* is jointly exogenous. This implies that the entry into a given status and exit from it may be estimated using a probit model.

1.2.1 Defining reliability function

In order to simplify a logarithm of the reliability function, we have introduced the following denotations:

$$y_{im}^{*} = \beta_m' X_{im} + \varepsilon_{im},\ m = 1,2,3 \tag{21}$$

A binary variable was defined $Y_{im} = 1$ if $y_{im}^{*} > 0$, while $Y_{im} = 0$ if $y_{im}^{*} \le 0$. It was assumed that random error terms ε_{im} can have a multi-dimensional normal distribution with an expected value of 0. The distribution of a variance-covariance matrix (denoted by *V*) takes the value equal 1 on the main diagonal; outside of the main diagonal there are the following correlations $\rho_{jk} = \rho_{kj},\ j,k = 1,2,3.$

With the above mentioned denotations, the reliability of the logarithm function will have the following form:

$$L = \sum_i w_i \log \Phi_3(\mu_i; \Omega) \tag{22}$$

where:

w_i – optimal weight;

Φ_j – distribuant of *j*–multidimensional normal distribution;

$\mu_i = (K_{i1}\beta_1' X_{i1}, K_{i2}\beta_2' X_{i2}, K_{i3}\beta_3' X_{i3})$;

$K_{ik} = 2Y_{ik} - 1$ for every *j,k=1,…,3*;

Ω includes elements Ω_{jk}, where $\Omega_{jj} = 1$ for *j=1,2,3*; but

$$\Omega_{21} = \Omega_{12} = K_{i1}K_{i2}\rho_{21},$$
$$\Omega_{31} = \Omega_{13} = K_{i3}K_{i1}\rho_{31},$$
$$\Omega_{32} = \Omega_{23} = K_{i3}K_{i2}\rho_{32}$$

Maximizing the reliability function requires the three-equation probit model estimation. If the model is correctly specified, the obtained estimators are consistent and asymptotically effective. The reliability function in this case is based upon the three-dimensional normal model:

$$\begin{aligned} &P(Y_1 = 1, Y_2 = 1, Y_3 = 1 \mid X_1, X_2, X_3) = \\ &P(X_3'\beta_3 + \varepsilon_3 > 0, X_2'\beta_2 + \varepsilon_2 > 0, X_1'\beta_1 + \varepsilon_1 > 0) = \\ &P(X_3'\beta_3 + \varepsilon_3 > 0 \mid X_2'\beta_2 + \varepsilon_2 > 0, X_1'\beta_1 + \varepsilon_1 > 0) \times \\ &\times P(X_2'\beta_2 + \varepsilon_2 > 0 \mid X_i'\beta_1 + \varepsilon_1 > 0) \times \\ &\times P(X_1'\beta_3 + \varepsilon_1 > 0) \end{aligned} \tag{23}$$

1.2.2 Cholesky decomposition of error covariance matrix

Equation (23) includes unobserved conditional variables which are correlated with one another. However, if it were possible to find a good approximation for the conditional distribution, the reliability function will necessitate an estimation of unidimensional integral. In what way, however, can the conditional distribution be approximated?

For this aim, the Cholesky decomposition of error covariance matrix was considered:

$$E(\varepsilon\varepsilon') = V = Cee'C \tag{24}$$

where:
C – Cholesky's lower-triangle matrix for matrix *V*,

$e = \begin{bmatrix} e_1 \\ e_2 \\ e_3 \end{bmatrix} \sim \Phi_3(0, \mathrm{I}_3)$, where I_3 is individual matrix 3×3.

From the above it follows that:

$$\begin{aligned} \varepsilon_1 &= C_{11}e_1 \\ \varepsilon_2 &= C_{21}e_1 + C_{22}e_2 \\ \varepsilon_3 &= C_{31}e_1 + C_{32}e_2 + C_{33}e_3 \end{aligned} \tag{25}$$

where:
C_{jk} – *jk*-th element of matrix C.

The Cholesky decomposition made it possible to write down the equation (25) as:

$$
\begin{aligned}
&P(Y_1 = 1, Y_2 = 1, Y_3 = 1 \mid X_1, X_2, X_3) = \\
&P(X_3'\beta_3 + \varepsilon_3 > 0, X_2'\beta_2 + \varepsilon_2 > 0, X_1'\beta_1 + \varepsilon_1 > 0) = \\
&P(X_3'\beta_3 + \varepsilon_3 > 0 \mid X_2'\beta_2 + \varepsilon_2 > 0, X_1'\beta_1 + \varepsilon_1 > 0) \times \\
&\times P(X_2'\beta_2 + \varepsilon_2 > 0 \mid X_1'\beta_1 + \varepsilon_1 > 0) \times P(X_1'\beta_3 + \varepsilon_1 > 0) = \\
&= P(e_3 \le (X_3'\beta_3 - C_{32}e_2 - C_{31}e_1)/C_{33} \mid e_2 \le (X_2'\beta_2 - C_{21}e_1)/C_{22}, e_1 \le X_1'\beta_1 / C_{11}) \times \\
&P(e_2 \le (X_2'\beta_2 - C_{21}e_1)/C_{22} \mid e_1 \le X_1'\beta_1 / C_{11}) \times P(e_1 \le X_1'\beta_1 / C_{11})
\end{aligned}
\tag{26}
$$

Variables e, which show up in the above mentioned formula, have the normal standard distribution and are not correlated with one another. The first two conditional probabilities can be thus written as unconditional probabilities delineated based on cut variables originating from the standard normal distribution:

$$
\begin{aligned}
&P(X_3'\beta_3 + \varepsilon_3 > 0, X_2'\beta_2 + \varepsilon_2 > 0, X_1'\beta_1 + \varepsilon_1 > 0) = \\
&= P(\varepsilon_3 \le X_2'\beta_2, \varepsilon_2 \le X_2'\beta_2, \varepsilon_1 \le X_1'\beta_3) = \\
&= P(\varepsilon_3 \le (X_3'\beta_3 - C_{32}e_2^* - C_{31}e_1^*)/C_{33}) \times P(\varepsilon_2 \le (X_2'\beta_2 - C_{21}e_1^*)/C_{22}) \times \\
&\times P(\varepsilon_1 \le X_1'\beta_1 / C_{11}) = Q_3 \times Q_2 \times Q_1
\end{aligned}
\tag{27}
$$

where e_1^* and e_2^* have cut a one-dimensional standard normal distribution with upper parts cut at points $X_1'\beta_1 / C_{11}$ and $(X_2'\beta_2 - C_{21}e_1^*)/C_{22}$. The calculation Q_1 is relatively simple, and when we assume some specific values e^*_1 and e^*_2, we can also calculate Q_2 and Q_3, and so the total multidimensional probability.

1.2.3 Simulation method of maximizing reliability function

Parameter estimators in the three-dimensional probit model can be obtained based on the numeral integrating or simulation techniques. The most commonly used simulation technique is probably the Geweke-Hajiassiliou-Keane (GHK) simulation[14]. This simulator allows us to obtain values e_1^* and e_2^* through drawing from the standard normal distribution with upper parts cut at the specific points as described above. Then, in reoccurring series, it calculates multidimensional probabilities for values from Q_S. The process repeats calculations *R* times, and then, based on the probability values obtained in a simulation, an arithmetic average is calculated.

The method of estimating random error terms with upper parts cut from normal distributions can be produced by using generators of random numbers from continuous distributions in a unit interval per unit of interval of data and then calculating an inverse function to a distribuant (Stern, 1997).

Börsch-Supan and HajIassiliou (1993) list the main benefits of the GHK simulator in the context of multidimensional normal distributions for models with a cut dependent variable:

- simulated probabilities are not biased;
- obtained probabilities pertain to interval (0,1);
- simulator is a continuous and differentiated function of the parameters of the model.

Moreover, the GHK simulator with the multidimensional normal distribution is better than other simulation methods which were indicated in numerous articles (for example, HajIassiliou, McFadden and Ruud, 1994). The GHK simulator is also more effective, considering the probability estimation variance ,than other simulators such as the „acceptance-rejection"[15] or Sterna simulator[16].

[14] See eg. Geweke (1991), Hajivassiliou (1990), Keane (1994), Cappellari and Jenkins (2003) and others.
[15] More on this subject in: Nandi (2004).
[16] More on this subject in: Mariano (2000).

1.2.4 Conditional probabilities

The assumptions that have been made allow us to define the probabilities of being in a given state in year *t*, under the condition of the state in which the person was in years *t-1* and *t-2*:

– formula of the conditional probability of remaining in a given state[17] based on equations (13, 14, 15):

$$\begin{aligned}
&\Pr(Y_{it}=1 \mid Y_{it-2}=1, Y_{it-1}=1) = \Pr(y_{it}^{*}>0 \mid y_{it-1}^{*}>0, y_{it-2}^{*}>0) = \\
&\Pr(O_{it}\lambda+\varepsilon_{it}>0 \mid Z_{it-1}\gamma+v_{it-1}>0, X_{it-2}\alpha+u_{it-2}>0) = \\
&\frac{\Pr(\varepsilon_{it}>-O_{it}\lambda, v_{it-1}>-Z_{it-1}\gamma, u_{it-2}>-X_{it-2}\alpha)}{\Pr(v_{it-1}>-Z_{it-1}\gamma, u_{it-2}>-X_{it-2}\alpha)} = \\
&= \frac{\Phi_3(O_{it}\lambda, Z_{it-1}\gamma, X_{it-2}\alpha, \rho_{31}, \rho_{21}, \rho_{32})}{\Phi_2(Z_{it-1}\gamma, X_{it-2}\alpha, \rho_{32})}
\end{aligned} \tag{28}$$

– formula of the conditional probability of entry into a given state based on equations (13, 14, 15):

$$\begin{aligned}
&\Pr(Y_{it}=1 \mid Y_{it-2}=0, Y_{it-1}=0) = \Pr(y_{it}^{*}>1 \mid y_{it-1}^{*}>0, y_{it-2}^{*}>0) = \\
&\Pr(O_{it}\lambda+\varepsilon_{it}>0 \mid Z_{it-1}\gamma+v_{it-1}<0, X_{it-2}\alpha+u_{it-2}<0) = \\
&\frac{\Pr(\varepsilon_{it}>-O_{it}\lambda, v_{it-1}<-Z_{it-1}\gamma, u_{it-2}<-X_{it-2}\alpha)}{\Pr(v_{it-1}<-Z_{it-1}\gamma, u_{it-2}<-X_{it-2}\alpha)} = \\
&= \frac{\Phi_3(O_{it}\lambda, -Z_{it-1}\gamma, -X_{it-2}\alpha, -\rho_{31}, -\rho_{21}, \rho_{32})}{\Phi_2(Z_{it-1}\gamma, X_{it-2}\alpha, \rho_{32})}
\end{aligned} \tag{29}$$

where:

$$\lambda = Y_{it-1}Y_{it-2}\lambda_1' + Y_{it-1}(1-Y_{it-2})\lambda_2' + (1-Y_{it-1})Y_{it-2}\lambda_3' + (1-Y_{it-1})Y_{it-2}\lambda_4',$$

$$\gamma = (Y_{it-2})\gamma_1' + (1-Y_{it-2})\gamma_2'$$

2. Description of data and variables used in the empirical study

An empirical analysis of transfers between various statuses of professional activities in the personal life cycle requires an appropriate length of panel data. In the empirical research, data from the CHER (Consortium of Household Panels for European Socio - Economic Research) database have been used. The CHER is a harmonized and standardized microeconomic database created of already existing panels concerning life conditions of persons and households in the European Union before the 2004 accession as well as those in Poland and Hungary. The database includes detail data on earnings and professional activities of persons, their education, employment, work history etc. It also comprises variables describing social relations and subjective feelings of the households members as well as specific data on the respondents' households [18].

This article is based upon the Polish panel data between 1997-2000. This database has been chosen because of its four-year data. The initial unit of study is a person. The sample was limited to persons aged 20-65. Table 2.1 shows the main descriptive statistics of real net income for persons in years 1997-2000

[17] The conditional probability of persisting in a given state as well as entry to it have been calculated based on the program mvdist_gen written by J.Mycielski.

[18] Ciecieląg, Tomaszewski (2003).

with the normal distribution[19]. Based on an average and median we can observe that income, over the period of the study, did not change much.

The selection of explanatory variables was based on the earlier studies concerning a labour market analysis. The independent variables used in the two-equation probit model with endogenous switching, in the „transfer" equation come from year *t-1*, yet in the case of the three-equation probit model with endogenous switching the variables in the „transfer" equation come from year *t-2*.

Table 2.1. Descriptive statistics for net income of persons

Descriptive statistics	**Year**			
	1997	**1998**	**1999**	**2000**
Sample quantity	6072	6013	5931	5923
Median	7742 PLN	7843 PLN	7599 PLN	7595 PLN
Average	9899 PLN	9628 PLN	9419 PLN	9474 PLN
Minimum	0 PLN	0 PLN	0 PLN	0 PLN
Maximum	404736 PLN	206173 PLN	256423 PLN	345303 PLN

Source: Own compilation

Variables pertaining to demographic characteristics:

- **age** – expressed in years. The age of the respondent carries a lot of information. Particularly, it indicates the possibility to undertake employment – excluded during school years or interfering with investments in further education or parental obligation in the case of having a small child. The age is generally highly correlated with the employee's years of employment[20].

At first, in the „transfer" equation also the age square was included because it could have been seen that the impact of the person's age on the conditional probability of being in a given state is not linear. However, this variable turned out to be insignificant as the descriptive statistic of the place of living.

Variables pertaining to human capital:

- **education –** takes the value of 1, if the person possess a higher education and 0 if the person has a secondary or primary education. Only such encoding of the variable allows us to reject the null hypothesis regarding the insignificance of the education variable. The subject literature discusses the fact that human capital, and particularly education, is a key determinant of activities on the labour market.
- **occupation** – takes the value of 1 if the occupation requires a higher level of qualifications (specialists, higher level managers, administrators), 0 – in all other cases. The level of education and occupation to a large degree determines the chances of the person on the labour market, although it should be added that these are strongly connected[21].

At first, this research included the variable describing the number of months spent on unemployment during the last 2 years, duration of professional inactivity expressed in months over the last 2 years and whether the respondent is currently looking for employment were all included, yet these turned out to be insignificant.

Variables pertaining to household structure:

- **children** – takes the value of 1 if there are children in the family aged below six, 0 - otherwise. The subject literature indicates that one of the main conditions of personal professional activities is the presence in the household of persons requiring care.

[19] Real net income in currency from year 2000 was considered (deflators for the following years: 1 [2000], 1·1,073 [1999], 1·1,073·1,118 [1998], 1·1,073·1,118·1,149 [1997]). Inflation in years 1997-1999 was as follows: 14,9%, 11,8%, 7,3%. „Consumption goods and services price indicators for years 1950-2002"

[20] Sztanderska, Grotkowska (2007).

[21] As above

- **retiree in household** – takes the value of 1 if there is a retired person in the household, 0 - otherwise.
- **unemployed in household** – takes the value of 1, if there is an unemployed person in the household, 0 - otherwise
- **marital status** – takes the value of 1, if the person is married, 0 - otherwise. The differentiation of a greater number of levels of this variable turned out to be insignificant.

At first, the „transfer" equation also included the following variables: self-employed partner (takes the value of 1 if the partner has his/her own business), number of persons in the household, sociological type of the family (one person, one parent with children, 2 parents with children, a couple with no children), however those turned out to be insignificant.

Other variables:

- **transfer** – takes the value of 1,if the transfer is private, 0 - otherwise.

The above mentioned variables included in the „transfer" equation were also used in the „selection" equation. For the model to be identifiable, the regressors that have impact on the status of the person in year *t-1* but not in the following year, also had to be found. The variables used as instruments were as follows (are included in a vector X_{it-1}):
- **gender** – takes the value of 1 for a man and 0 for a woman,
- **city** – takes the value of 1, if the respondent lives in a city, 0 - otherwise,
- **car** – takes the value of 1,if the respondent has a car, 0 - otherwise,
- **computer** – takes the value of 1 if the respondent has a computer, 0 - otherwise,
- **telephone** – takes the value of 1,if the respondent has a telephone, 0 - otherwise,
- **satisfaction from income** – takes the value of 1 if the respondent is satisfied with his/her income, 0 - otherwise.

The region where the person lives as well as the type of property (ownership, rent) are variables from the „selection" equation that turned out to be insignificant, therefore they were not included in the final model.

3. Results obtained based on parametric method for employment status

3.1 Application of two-equation probit model with endogenous switching

The results obtained will be presented in two parts. First, the estimation of the correlations between unobserved variables and the results of the tests on the exogeneity of the initial conditions and „interdependence of states" are presented; then the correctness of the instruments chosen are gauged. Then, the estimates of the impact of particular independent variables on the conditional persistence or change of a given status are given..

3.1.1 Testing exogeneity of initial conditionsand existence of „interdependence of states"

In order to examine whether the „selection" equation is exogenous, the significance tests for the individual correlations and the joint significance of the correlation coefficients were performed. In the lower part of Table 3.1.1 there are estimates of the individual correlations. The interesting part is that they take negative values regardless of the status in which the person was in the previous period; they are also numbers other than zero. Thus, the correlation between the unobserved variables that have impact on the initial state of the person as well as his/her conditional current state is negative, which can be interpreted the same way as the Galton regression (Swaffield, Stewart, 1999).. Furthermore, the correlations mentioned below are statistically significant.

In Table 3.1.1 the test for the exogeneity of the initial conditions, which checks whether ρ_1 and ρ_2 jointly equal zero, has also been included. However, this hypothesis is strongly rejected ($\chi^2(2)=64{,}81$; p-value=0,000<α, where α is a significance level), which means that the status in which the person was in year *t-1* is endogenous. This conclusion necessitates the estimation of two equations: „selection" and „transfer".

The result of the test of the joint significance of the instruments used in the „selection" equation has also been included in Table 3.1.1. The null hypothesis regarding the joint insignificance of these variables has been rejected ($\chi^2(5)=641,81$; p-value=0,000<α, where α is a significance level).

The last row of the Table presents the test verifying the „interdependence of states", which means that being in a given state on the labour market in the previous period changes the impact of individual characteristics on being in the same state in the current year. Based on the test, the null hypothesis regarding the lack of the „interdependence of states" in the model, has been rejected ($\chi^2(9)=1707,34$; p-value=0,000<α, where α is a significance level).

3.1.2 Impact of independent variables on the conditional probability of transfer to employment status

The impact of regressors on the conditional probability of the transfer to a given status in year *t*, subject to the status in the previous year and on the assumption of the endogeneity of the initial conditions is presented in Table 3.1.2. The results of the estimation obtained on the assumption of the exogeneity of the initial conditions are presented in Table 3.1.3.

Table 3.1.1. Results of estimates of correlations between equations for employement status, tests for: independence of initial conditions, significance of instruments used and the presence of the „interdependence of states"

Coefficients of correlations between equations	**Parameter**	**t**	
ρ_1	- 0,29561651	- 2,54	
ρ_2	- 0,66626867	- 4,37	
„Initial conditions problem " Test for the exogeneity of the initial conditions			
Null hypothesis	**Number of degree of freedom**	**chi2(k)**	**Prob > chi2(k)**
$\rho_1 = \rho_2$	2	64,81	0,000
Significance tests: all variables in „transfer" i „selection" equations as well as instruments used			
All variables are insignificant in the „transfer" equation"	16	487,43	0,000
All variables are insignificant in the „selection" equation	13	2527,50	0,000
Instruments are insignificant in the „selection" equation	5	641,81	0,000
„Interdependence of states"			
$\eta_1 = \eta_2$	9	1707,34	0,000

Source: Own compilation

Comparing the results presented in both tables, we can notice that the assumption of the exogeneity of the initial conditions leads to an increase in the impact of regressors on the phenomenon studied and also increases the absolute value of test *t* - student statistics. These differences stem from the fact that the model estimated on the assumption of the exogeneity of the initial conditions is not correctly specified and the obtained estimators are biased. Only the independent variable connected to a professional occupation requiring higher education has a higher *t* statistics in the case of the assumption of the endogeneity of the initial conditions. The direction of interdependencies is the same in both cases.

At first, biased estimators was considered under the condition of the person having an employed status in period *t-1*. In addition, some of the independent variables turned out to be statistically significant at the significance level equalled five percent or higher.

A higher education as well as occupation that requires higher qualifications have positive impact on the conditional probability of the persistence of employed status; these variables have proved to be significant at a 10% level. However, a negative impact on the conditional probability of the persisting in the state in the period *t* exhibits the following determinants: the presence of a retired or unemployed person in the family (variables significant at a confidence level of 5%). Variables such as the presence of children below the age of 6 or the receipt of transfers. turned out to be insignificant for the phenomenon studied .

On the other hand, having an unemployed person in the family and a spouse has positive impact on the probability of the transfer to employed status (variables significant at a confidence level of 5%). A negative impact is exerted by the following variables: age, presence of a retired person as well as an occupation that requires higher qualifications (variables significant at α=0,05). Variables insignificant for explaining differentiation in the probabilities concerning transfer to employment are: education, having children below the age of 6 as well as the receipt of transfers (see Table 3.1.2). It is important to notice that all variables, except for the presence of an unemployed person in the family has proved to be highly significant when explaining the status of the person in period *t-1*.

Table 3.1.2. The estimation results of the conditional probability of transfer to an employed status in year *t*, subject to the status in the prior year and under the assumption of endogeneity of the initial conditions.

Independent variables (measured in year t-1)	**Pr(being employed in t-1)**		**Pr(being employed in t| being employed in t-1)**		**Pr(being employed in t | being unemployed in t-1)**	
	Parameter	**t**	**Parameter**	**t**	**Parameter**	**t**
Education	0,1811396	3,36	0,1952926	1,82	0,1319492	1,22
Children aged 6 and younger	- 0,2490211	- 9,76	- 0,063114	- 1,26	- 0,0452028	- 0,97
Transfer	- 0,0002944	- 24,67	- 0,1986663	- 1,40	- 0,0254517	- 0,35
Unemployed in the family	- 0,0075192	- 0,29	- 0,6445318	- 14,42	0,4710931	10,76
Marital status	0,3601285	11,63	0,0539101	0,84	0,1371601	2,46
Retired in the family	- 0,408659	- 15,62	- 0,1917937	- 3,13	- 0,1077803	- 2,07
Age	- 0,0232397	- 18,89	- 0,0025593	- 0,88	- 0,0235227	- 9,12
Occupation	0,5736877	13,35	0,1558783	1,86	- 0,3451011	- 3,50
Constant	0,2962271	5,41	2,651692	17,52	- 0,99321	- 9,17

Source: Own compilation

Based on Table 3.1.2, it is worth noticing that the direction of the dependency between the regressors and the dependent variable is conditioned by the state in year *t-1*. For example, it can be seen that performing a job that requires higher qualifications increases the probability of remaining in employed status, but also lowers the probability of transfer from the employed to a different state, although the *t*-student statistics is in the latter case greater in terms of its absolute value. On the one hand, the presence of an unemployed person in the household lowers the probability of the persistence of employment but, on the other h, increases the chance [22] to become employed in period *t*, if the person was outside of this status in period *t-1*.

Summing up this part of the article, it should be emphasized that there are sizable differences in the impact of independent variables on the conditional probability of being employed in period *t* dependent on the status of that person a year earlier.

3.1.3 Forecasting probability of transfer to an employed status and duration of employed status

An alternative and more intuitive method for analyzing the results stemming from these estimates is to calculate probabilities of entering employed status and remaining in it for persons with different combinations of characteristics. If we assume that all additional processes are in the stationary equilibrium, we can determine the probability of having employed status at a given point in time as well as calculate an average time (median time) of the employment persistence and an average time (median time) of being outside of full-time employment status. In order to obtain these indicators, estimators, including the initial conditions, have been calculated. The summary of the various forecasts generated based on formulas (8), (9) as well as the use of parameter estimations presented in Table 3.1.2, have been included in Table 3.1.4.

[22] The word „chance" will be used interchangeably with the word „probability".

The reference person is a man aged 35, with no higher degree, living in the city, not having an unemployed or retired person in the family, having children aged 6 or below, performing an occupation which does not require higher qualifications, satisfied with his income, without a car, having a telephone, and not receiving any transfers. For such a defined person, the forecast probability of the persistence of employment is 0,93 and the chance of transfer to employment status is 0,11. Calculated on the assumption of the stationarity of the median duration of employment is 9 years, while median time outside of the employed status is 6 years.

Table 3.1.3. The results of probability estimates of the transfer to an employed status in year *t*, subject to the status in the prior year and under the assumption of the exogeneity of the initial conditions.

Independent variables (measured in year t-1)	**Pr (being employed in t | being employed in t-1)**		**Pr (being employed in t | being unemployed in t-1)**	
	Parameter	**t**	**Parameter**	**t**
Education	0,2319447	2,14	0,2742561	2,32
Children aged 6 and younger	- 0,1132197	- 2,33	- 0,1363931	- 2,75
Transfer	- 0,0001437	- 4,94	- 0,0000383	- 2,81
Unemployed in the family	- 0,6639842	- 15,02	0,5234523	2,81
Marital status	0,1221757	2,02	0,2123661	3,57
Retired in the family	- 0,2879107	- 5,67	- 0,2428838	- 4,56
Age	- 0,0061032	- 2,32	- 0,0327084	- 13,44
Occupation	0,2437116	3,13	- 0,0217924	- 0,21
Constant	1,574204	14,63	- 0,3479532	- 3,75
Number of observations	6099		9033	
LR chi2(8)	347,83		516,13	

Source: Own compilation

If the person studied is a woman with the same characteristics (case 2) then the expected probability of persistence in employment will be 0,91 and the expected chance of entry into the employed status will amount to 0,08. On the assumption of stationarity, the median duration of employment will be 7,72 years, while the median time spent outside of employment will equal 8 years. It is important to notice that being a woman has a negative impact on the persistence of employment and chance of transfer to employment as well as it lengthens the time spent outside of employment. All this proves that, unfortunately, women are in a worse situation on the labour market than men.

A higher education with all other characteristics, the same as for the reference person, leads to an increase in the both probabilities to 0,96 and 0,16 respectively. The Median duration of having employment status more than doubles and amounts to 17 years, while the median time of being outside of this status drops down to 4 years.

What is interesting is that for persons with a higher education and without children aged 6 or below with all other characteristics the same as for the reference person, the above mentioned probabilities amount to 0,962 and 0,21, respectively. The median duration with the employed status will be 18 years, while the median time of being outside of employment will decrease to 3 years.

In addition, if we assume that a person receives transfers, the probability of being in employment will drop down to 0,94. This also causes a decrease in the median time spent in the employed state to 12 years, while the median time spent outside of this status will amount to 3 years.

Introducing an additional assumption that the person owns a car, but does not receive any transfers, leads to a change in probabilities to 0,95 and 0,16, accordingly. The median time spent outside of employment will total 4 years.

The assumption that the person performs a job that requires higher qualifications, guarantees highest probability of employment on the level of 0,964.

Table 3.1.4. The conditional probability and statistics describing the distribution of the persistence of the employed status

No.	Characteristics	The conditional probability of persistence of employed status	The conditional probability of transfer to employed status	Probability of having an employed status at a given point in time	Median time of remaining in the employed status (in years)	Median time of being outside of the employed status (in years)
1	a) A man, b) aged 35, c) no degree, d) satisfied with income, e) performing an occupation not requiring higher qualifications, f) living in the city, g) having children aged 6 or below, h) not having an unemployed or retired person in the family, i) without a car, j) having a telephone, k) not receiving any transfers	0,9255341	0,10828913	0,59253707	8,957206518	6,04770096
2	Point 1 but a woman	0,91417	0,083084	0,491871603	7,72405835	7,99114438
3	Point 1 but having a higher education,	0,960487	0,16133932	0,80327337	17,19335428	3,93947583
4	Point 3 but not having children aged 6 or below,	0,9628377	0,21370965	0,851867457	18,30313029	2,88295813
5	Point 4 but receiving transfers,	0,9453452	0,20477969	0,789331018	12,33245462	3,02504595
6	Point 3 but having a car,	0,9599052	0,15594029	0,795471311	16,93877045	4,08859103
7	Point 6 but performing an occupation requiring higher qualifications	0,964965	0,13625817	0,795467618	19,43578719	4,73198206

Source: Own compilation

Summarizing the results included in Table 3.1.4, it is worth noticing that the person who is a long time in employment state spends relatively little time outside of it. In other words, such person relatively easily returns to professional activity after the period of not being active. Moreover, it seems that having a higher education has relatively the strongest positive effect on the probability of the persistence and transfer to employment as well as the median time spent in that state; this variable relatively lowers the median time spent outside of this status the most. Generally, not having children aged 6 or below also has a sizable positive impact on the probability of transfer to employment status.

3.2 Application of three-equation probit model with endogenous switching

The results of the estimation of the three-equation model will be presented in two parts. At first, the estimates of the correlations between unobserved variables and the results of tests for the exogeneity of the initial conditions and „interdependence of states will be presented". Then, the estimates of the impact of individual independent variables on the conditional probability or the persistence of the current status will be given .

3.2.1 Testing for exogeneity of initial conditions and existence „interdependence of states"

In order to check the exogeneity of the „selection" equation, tests for the significance of individual correlations and a joint significance of correlation coefficients have been conducted. In the upper part of Table 3.2.1. there are estimates of the correlations between unobserved variables that have impact on the person's initial state and on the conditional state of the person in period *t-1* (ρ_{21}), estimates of correlations between unobserved variables that have impact on the person's initial and conditional state of the person in period *t* (ρ_{31}) as well as the estimates of the correlation between unobserved variables that have impact on the person's state in period *t-1* and on the conditional state of the person in period *t* (ρ_{32}). All correlation coefficients take negative values regardless of the status of the person in periods *t-2*, *t-1* and are statistically significant.

Table 3.2.1. Results of estimates of correlations between employed statuses, tests for: independence of the initial conditions, significance of instruments used and existence of „interdependence of states"

Coefficients of correlations between equations	**Parameter**	**t**	
ρ_{21}	- 0,0667093	- 1,66	
ρ_{31}	- 0,0651478	- 1,99	
ρ_{32}	- 0,104112	- 3,27	
„Initial conditions problem" (test for exogeneity of the initial conditions)			
Null hypothesis	**Number of degrees of freedom**	**chi2(k)**	**Prob>chi2(k)**
$\rho_{21} = \rho_{31} = \rho_{32} = 0$	3	14,44	0,0024
$\rho_{21} = \rho_{31} = 0$	2	11,15	0,0038
$\rho_{31} = \rho_{32} = 0$	2	13,69	0,0011
$\rho_{21} = \rho_{32} = 0$	2	11,34	0,0034
„Interdependence of states"			
$\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4$	20	656,20	0,000

Source: Own compilation

Table 3.2.2. Estimation results of the conditional probability of transfer to employed status in year *t*, dependent on statuses in periods *t-1*, *t-2*, on the assumption of endogeneity of the initial conditions. GHK simulator with 5 repetitions.

Independent variables (measured in year t-2)	Pr (being employed in t-2)		Pr (being employed in t-1| being employed in t-2)		Pr (being employed in t-1 | being employed in t-2)		Pr (being employed in t | being employed in t-1,t-2)		Pr (being employed in t | being employed in t-1, t-2)		Pr (being employed in t | being employed in t-1 and outside of the status in t-2)		Pr (being employed in t | being unemployed in t-1 and employed in t-2)	
	Parametr	**t**	**Parametr**	**t**	**Parametr**	**t**	**Parametr**	**t**	**Parametr**	**t**	**Parametr**	**t**	**Parametr**	**t**
Education	0,1812091	2,75	0,4127116	3,55	0,087251	0,58	0,3481744	2,77	0,2433428	1,50	0,6198	1,81	-0,3007023	-0,82
Children aged 6 and younger	-0,2251769	-7,27	-0,1309798	-2,22	-0,166724	-2,77	-0,103134	-1,54	-0,1307784	-1,85	-0,124792	-0,90	0,1114457	0,82
Unemployed in the family	0,0376366	1,18	-0,6220729	-11,67	0,520089	9,39	-0,859668	-13,92	0,4249595	6,28	0,1958022	1,52	-0,148724	-1,15
Marital status	0,367282	9,77	0,1550858	2,89	0,520089	9,39	0,0530655	0,62	0,1361105	1,62	0,4184128	2,26	-0,2023895	-1,13
Retired in the family	-0,3726978	-11,76	-0,264616	-2,13	0,196424	2,73	-0,336718	-4,79	-0,1828451	-2,44	-0,270679	-1,77	0,0253571	0,15
Age	-0,0232015	-15,58	-0,005384	-1,69	-0,034695	-11,79	-0,005996	-1,68	-0,0331854	-9,98	-0,037054	-5,48	-0,0100664	-1,40
Constant	0,2579099	3,92	1,931119	11,02	-0,331224	-2,87			-0,490415	-3,78	1,341871	5,23	0,9671137	3,85

Source: Own compilation

Table 3.2.1 also includes the test for the exogeneity of the initial conditions in period *t-2*, checking whether ρ_{21} and ρ_{31} jointly equal zero. The null hypothesis is strongly rejected ($\chi^2(2)=11,15$; p-value=0,0038<α, where α is a significance level), which means that the status in which the person was in year *t-2* was endogenous. The next, step was to carry out the test for the exogeneity of the initial conditions in period *t-1*, examining whether ρ_{21} and ρ_{32} jointly equal zero. Also, this null hypothesis is strongly rejected ($\chi^2(2)=11,36$; p-value=0,0034<α, where α is a significance level), which means that the status in which the person was in year *t-1* was endogenous.

Moreover, the test for the hypothesis regarding the exogeneity of the initial conditions has been performed; to control whether $\rho_{21,}$ ρ_{23} as well as ρ_{31} jointly equal zero, but also this hypothesis should be rejected ($\chi^2(3)=14,44$; p-value=0,000<α, where α is a significance level). This result shows that the statuses of the person in years *t-2*, *t-1* are jointly endogenous. This result implies the necessity to jointly estimate three equations.

In the last row of Table 3.2.1 there is the test verifying the „interdependence of states", i.e., that being in a given state on the labour market in period *t-2* affects the impact of individual characteristics on the probability of being in the same state in year *t-1* as well as being in a given state on the labour market in the current year. Based on the results of the test, the null hypothesis regarding the lack of the „interdependence of states" in the model ($\chi^2(20)=656,20$; p-value=0,000<α, where α is a significance level) has been rejected.

3.2.2 Impact of independent variables on conditional probability of transfer to employed state

Table 3.2.2 presents the estimation of the impact of the regressors on the conditional probability of moving to a given state in year *t*, depending on the person's status two years earlier and on the assumption of the endogeneity of the initial conditions. Table 3.2.3 shows the results of the estimation on the assumption of the exogeneity of the initial conditions. Comparing the results found in both tables, we can notice that the introduced assumption regarding the exogeneity of the initial conditions in most cases leads to an increase in the effect of the regressors on the phenomenon studied and also increases the absolute value of *t*- Student statistic. The direction of the relation is the same in both cases.

Table 3.2.3. Estimation results of the conditional probability of transfer to employed status in year *t*, dependent on statuses in periods *t-1*, *t-2*, on the assumption of the exogeneity of the initial conditions.

Independent variables (measured in t-2)	**Pr (being employed in t| being employed in t-1, t-2)**		**Pr (being employed in t | being employed in t-1, t-2)**	
	Parameter	**t**	**Parameter**	**t**
Education	0,3640396	2,91	0,2666789	1,65
Children aged 6 and younger	- 0,1096556	- 1,62	- 0,1377455	- 1,94
Unemployed in the family	- 0,8458425	- 14,01	0,417663	6,22
Retired in the family	- 0,348564	- 4,98	- 0,1930177	- 2,58
Age	- 0,0067416	- 1,82	- 0,0336568	- 10,10
Marital status	0,0672917	0,78	0,1448306	1,73
Constant	1,801805	11,91	- 0,4431269	- 3,50
Number of observations	3929		5523	
LR chi2(6)	243,50		209,28	

Source: Own compilation

Based on Table 3.2.2 we can discern that a higher education has a positive influence on the conditional probability of the persistence of employed status over 3 periods (at a significance level of 5%). A negative impact on the conditional probability of remaining in that state in period *t* has the following determinants: the presence of an unemployed or retired person in the family (at a significance level of 5%) and age (at a significance level of 10%). Being in a marital relation as well as having children aged 6 and younger has proved to be insignificant for explaining probabilities of this status lasting. However, similarly to the two-equation models, these variables are significant for determining the personal status in period *t-2*, as well as the personal status in period *t-1* subject to its status in period *t-2*.

Age as well as having a retired person and children aged 6 and younger in family has a negative influence, but the presence of children becomes significant only at α=0,1. Insignificant variables are: being in a marital relation and education (see Table 3.2.2).

Based on Table 3.2.2, we can also observe that the direction of dependencies between the regressors and dependent variables is dependent upon the person's state in year *t-2* and *t-1*. For example, having an unemployed person in the family lowers the probability of the persistence of employment but also increases the chance to become employed in year *t*, if the person was outside of this status in years *t-2* and *t-1*.

The coefficients for the financial ,transfer and occupation variables are not presented in Table 3.2.2 and Table 3.2.3 because of a statistically insignificant influence of these variables on each the conditional probability of transfer to the employed status in period *t*, depending on the statuses in periods *t-1*, *t-2*, on the assumption of the endogeneity and exogeneity of the initial conditions.

Summarizing this part of the work, it should be emphasized that there are great differences in the impact of the independent variables on the conditional probability of having employment in period *t*, depending on the statuses the person held two years and one year earlier. Moreover, this research shows, as we expected, that not only being in a given state but also entering this state is dependent, on the one hand upon demographic characteristics and human capital and on the other, the characteristics of the household.

3.2.3 Forecasting the probability of transfer to employed status

An alternative method for analyzing the results stemming from the obtained estimates is to calculate probabilities of entry into employed status and exit from it for persons with different combinations of characteristics. A summary of the forecasts, obtained based on formulas (28) and (29) as well as parameter estimates presented in Table 3.2.2 can be found in Table 3.2.3.

The reference person is a man 35 years old, not having a higher degree, living in the city, not having an unemployed or retired person in the family, having children aged 6 and younger, satisfied with his income, without a car but having a telephone. For this person, one expects the probability of the persistence of employment of 0,98 and his expected chance of entry into employed status is approximately 0,1.

If the person studied is a woman with the same characteristics (case 2), than her expected probability of persisting in employment is 0,97 and her expected chance of transfer to employed status is about 0,08. A higher education with all other characteristics as those for the reference person will cause an increase in both probabilities to 0,99 and 0,14, accordingly. If we also assume that this person does not have children at the age of 6 or less, the probability of transfer to employed status increases to 0,18.

Summing up the results from Table 3.2.3, it is important to notice that individual differences in the probabilities of entry to employed status are greater than those for the probabilities of remaining in a given status.

Table 3.2.4. The conditional probability of the persistence of and change in employment

No.	Characteristics	The conditional probability of persistence of employed status	The conditional probability of transfer to employed status
1	a) A man, b) aged 35, c) lack of higher education d) satisfied with income, e) living in the city, f) having children aged 6 or below, g) not having an unemployed or retired person in the family, h) without a car, i) having a telephone.	0,97536686	0,09887365
2	Point 1, but a woman	0,97462302	0,07764308
3	Point 1 but having a higher education,	0,98975275	0,1434579
4	Point 2, but not having children aged 6 or below.	0,99237307	0,18086321

Source: Own compilation

Conclusion

In this article, I have studied the transfer of persons aged 20 - 65 years old to full-time employment status on the labour market based on the data from the CHER panel. The use of the panel data allowed me to track the movements of the same person over time and consequently to answer the question concerning the probability of transfer to a given state on the labour market.

The research results show that the state of the person in a given year is dependent not only upon, his/her state in the previous year, but also upon being in that state in years before that period. The null hypothesis assumes the equality of the correlation coefficients in the three equations but in all cases considered it has been rejected. As a result of the above, we have the so-called the „initial conditions problem", which means that the person's state in years *t-2* and *t-1* is endogenous in relation to the situation in year *t*, which in turn,, implies the necessity of estimating three equations.

Moreover, the study shows that the impact of individual characteristics of persons on the conditional probability of being in a given status depends on the person being employed in the past, which confirms the rejection of the null hypothesis regarding the „interdependence of states". As a result of this study, we can determine that, as expected, being in the state studied just like entering that state are conditioned by the demographic characteristics and human capital of the respondent as well as the characteristics of the household, although the impact of these variables depends on the previous state of that person.

In conclusion, it is worth to add the summation of the results of the both models (two-equation and three-equation probit modes with endogenous switching). On the one hand, we can point out that both in the two- and three-equation model, having a higher education positively impacts the conditional probability of the persistence of employment. On the other hand, having a higher education is not significant for explaining the probability of transfer to employment after periods spent outside of this status. If we look at the forecast probabilities, we can see exactly that a higher education most strongly increases the probability of the persistence of employment status and transfer into it, strongly increases the time spent in employment as well as decreases the time spend outside of it. These results are congruent with the results of many other studies (eg. Sztanderska, 2007, Bukowski 2005, 2008), as well as with the results presented in the second part, which show that persons with a higher education have a better situation on the labour market. Based on

the results obtained, it is worth to emphasize a great importance of a higher education and also general human capital that prove to be the key to professional success. At this moment, it should be pointed out that women' situation on the labour market is worse than that of men's . This study shows that being a woman has a negative impact on the forecast probability of the persistence of employment and transfer to it, and increases the time spent outside this status. Gershuny, SullIan (2003), Bovenberg (2005) argued that the employment rate of women will greatly increase with an increase in general education level and the input of men to voluntary labour. Thus, the increase in human capital level in society can also help in lowering the existing differences in professional activities between genders.

On the one hand, working in an occupation that requires higher qualifications increases the chance of persisting in employment – working in such an occupation is tied with having a larger pool of human capital and so should positively impact the personal situation on the labour market. On the other hand, this variable decreases the probability of transfer from another status to full-time employment. That does not have to contradict the previous conclusion – persons with higher qualifications may prefer other forms of employment, for example, self-employment with other employees to full-time employment by an employer. Unfortunately, the data used in this study does not allow us to confirm or to reject this hypothesis.

In this study, we have also showed that the presence of an unemployed person in the family has positive impact on the probability of moving to employed status. Thus, we can conclude that the presence of an unemployed person in the family and accompanying decrease in the household income stimulates respondents to effectively look for employment. However, which may be surprising the same variable lowers the chance of remaining in employment. Thus, the presence of an unemployed in the family may show a generally weak position of the entire household on the labour market, including the respondent, who may also have problems with maintaining his/her position or may find only temporary work, part-time or short-term employment. This instability of employment may be, on the one hand, a sign of weak fit between the respondent, his/her household and labour market requirements. On the other hand, it may result from the preferences of a given person i.e., that the individual due to a relatively low pay for the work performed may prefer to receive social benefits and remain in professional inactivity. However, in order to maintain rights to social benefits, the respondent must once in a while become professionally active and so these preferences lead to a large mobility of the respondent between active and inactive statuses on the labour market, which seems to be congruent with thus far presented research outcome. Yet, possessing the abilities and qualifications that do not match with the requirements of the labour market may also lead to the instability of the professional path,. Without a more thorough analysis it is difficult to pinpoint the real reasons of such impact of the presence of an unemployed person in the family on the professional status of the respondent. For sure, it is worth to analyze this matter further, and in the case of proving one of the hypotheses, a change in assigning social benefits as well as their amount should be reconsidered. Or we should reconsider how to help the unemployed in getting qualifications required for persistent employment. The empirical study of these matters, however, falls outside of the scope of this work.

Having children below the age of 6 in the family has proved to be insignificant for explaining the conditional probability of personal status in year *t* dependent on the statuses in *t-1* and *t-2*, although this variable has a statistically significant negative impact on the probability of being employed in period *t-2* and period *t-1* subject to the status of the person in period *t-2*. Moreover, the absence of children in this age group strongly increases the forecast probability of transfer to employed status. Therefore, we can assume that the presence of small children in the family has a somewhat negative influence on professional activities of the respondent. Sztanderska (2007) showed that the main condition of the probability of having employment is exactly having children in pre-school age or persons who require care. This stems from the fact that households with small children create their professional activeness differently than other households. The Sztanderska's analysis shows that the presence of children till the age of three has a particularly strong negative impact on persistent employment of women because it stimulates them to resign from professional activities. However, having children aged 4-6 does prompt women to return to the labour market, but in the case of difficulties in finding employment, these women often become unemployed. These tendencies may be seen as significant reasons for lower retirement benefits and lower earnings of

women[23]. In this work the impact of small children on professional activities of the person has been analysed jointly for men and women. An interesting extension of this work would be to conduct separate analyses for women and men as well as include the presence of children up to the age of 4 and higher.

As for the variable describing marital status, it has proved to be significant only in the two-equation model and to have a positive influence on the probability of transfer to employment. We can assume that this is, to a certain degree, true. Sztanderska (2007) presents a quite surprising picture of employment in single-person households. It might be seem that single persons who do not have the possibility to be supported by other persons from the same household should be more motivated to take job.. However, we can observe quite an opposite situation, that is that persons living alone are often professionally less active than others . So we may draw the conclusion that the household with other adult persons stimulates professional activities of an individual[24]. We should also remember that the variable used in this study does not completely show whether the household contains one person or more. This could be the reason of the insignificance of this variable in a three-equation model as well as its insignificance it in explaining a chance for the persistence of employment.

To end this subpart, we should mention the impact of age on the probability of persistence of employment and transfer to employment ,which has proved to be negative. Although, this variable is significant in the three-equation model but taking into account that the null hypothesis concerning the exogeneity of all initial conditions was rejected at the beginning, we can expect that the model gives better results in the two-equation model. A negative impact of age is consistent with the results from previous subpart and other empirical articles showing an extensive unemployment problem in Poland in senior and pre-retired age groups. A negative relation between age and the probability of being employed also stems from the transfer of other people into retirement. At this point, we can also mention that the presence of a retired person in the family has a negative influence on not only on the probability of persisting in employed status but also on the probability of transfer to that state. If we assert that the presence of a retiree (who can be, for example, a spouse of the respondent) proves a generally higher average age in a given household, then the particular respondent may be getting closer to a retirement age,, transferring from professional activity to retirement. More or less, both situations (i.e., higher unemployment of older persons and their going into retirement) lead to lower professional activity of other persons and thus both hypotheses remain consistent with the results of this study. At this point, it is difficult to determine, the causes of this phenomenon. At the end, we should mention that, the receipt of transfers has proved to be totally insignificant for modelling the probabilities of moving to full-time employment.

In conclusion, based on this study, it can be established that the state of the person in a given year largely depends on his/her status in the previous periods, but it should be also emphasized that some of the existing characteristics of the individuals should be carefully scrutinized by labour market policy.

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Faculty of Economic Sciences
University of Warsaw
44/50 Długa St.
00-241 Warsaw
www.wne.uw.edu.pl